STATE & PRIVATE FORESTRY
FOREST HEALTH PROTECTION
SOUTH SIERRA SHARED SERVICE AREA

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Subject: Biological Evaluation of Forest Health concerns, Reservoir Forest Health Project, Pacific and Placerville Ranger Districts

Introduction

The Reservoir Project encompasses over 20,300 acres that overlap sections of Placerville and Pacific Ranger Districts, Eldorado National Forest. Forests considered for treatment are primarily mixed conifer types of fir or pine, with some areas of red fir type. Large sections are within the Crystal Basin, a critical water and power infrastructure licensed to Sacramento Municipal Utility District (SMUD) which services a large proportion of Sacramento and Placer counties. The Basin is a valued recreation destination that provides numerous outdoor activities year-round but also covers private timberlands, small residences, and Forest Service holdings. While wildfires in the past 30 years burned around the Basin, ignition risk is unnaturally high due to the extensive amount of visitor-dispersed use. Conservation and protection of unique Basin hallmarks and species, and continued sustainable management are planned through density reduction treatments such as prescribed burn and mechanical thinning. Forest Health Protection accompanied the Forest during a public meeting in 2018, but also made separate visits to assess current conditions on the ground. This report summarizes common observations and discussions of management recommendations as applies to insects and diseases found in the project area.

Observations

There are several predominant vegetation types in the Reservoir project: mixed conifer-white fir, mixed conifer-pine, red-fir, and variable-aged pine plantations. Most natural stands are multi-storied with predominantly ponderosa and sugar pines in the overstory, codominant with white fir and incense cedars, and thick understory of white fir, incense cedar, and black oak regeneration and saplings. Tan oak, madrone, and Douglas-fir are additional components here not found in lower Sierra Nevada. Brush species of manzanita, *Ceanothus* sp., and *Ribes* sp. were dense in areas not recently treated. Depending upon aspect and elevation, species dominance shifted quickly but noticed that conifers on poor soil were stunted and black oaks were prevalent. On drier

Image 1. Recently treated natural stand in Reservoir Project, February 2020.

southern facing slopes: Ponderosa, sugar, black oaks, and even incense cedars comprise a greater number of regeneration and overstory trees. White fir was still persistent even on these drier slopes, but not doing well – even when released, were quickly infested by bark beetles. White fir is better on colder, northern facing slopes but their high densities are an issue during drought events or perpetuating root disease infection points.

Natural areas visited in the project area were a mix of (recently) treated vs. untreated, depending upon distance to a road. General forests near main roadways like Icehouse Road appeared recently treated, current mortality low. Ponderosa and sugar pines were selected overstory, with white fir and incense cedar regeneration thick in the understory (see Image 1). Larger white firs were codominant with pines, even in higher abundance on good sites where treatments appeared light. Basal area remains high as most residual trees were of larger diameter, but brush component was minimal. Basal area jumped higher for natural mixed conifer stands beyond the boundary of older treatment units where stocking was immediately thicker and smaller trees numerous. Several root disease centers were identified outside recent treatment areas where firs were still in higher proportion.

Older pine plantations along the western shore of Union Valley Reservoir would be considered high risk for bark beetle attack. Average diameter of some stands visited during the field tour were between 12-16 inches, crowns overlapping, and thick regeneration of incense cedar grew in the understory (see Image 2). Younger pine

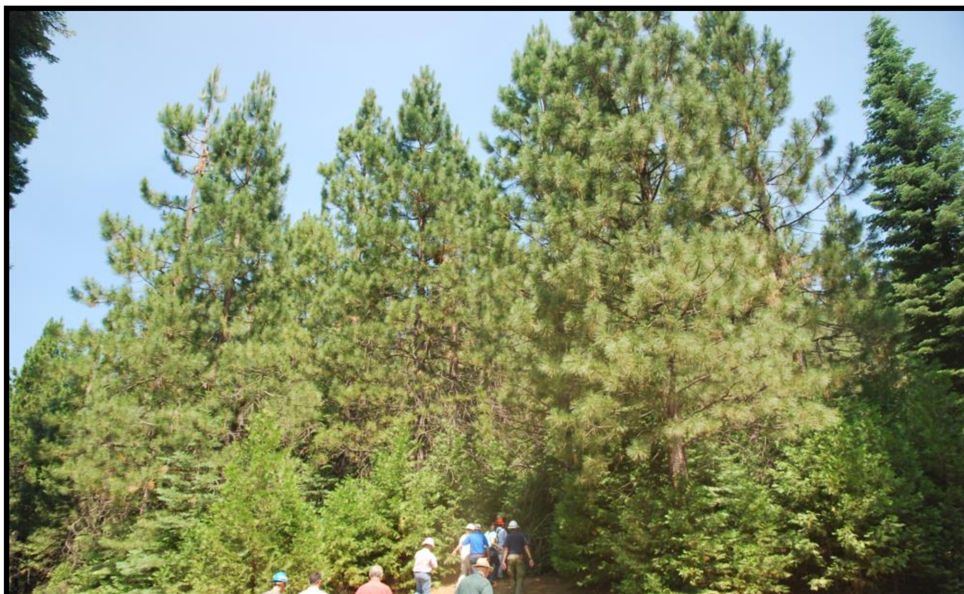

Image 2. Pine plantation on west side of Union Valley Reservoir.

plantations were healthy with enough room to still grow before crowns touch; however, sapling and pole sized sugar pines in all areas were observed with blister rust infection either on branches or boles, particularly where clusters were tight. Saplings and poles with bole infection are not expected to live to maturity as other insects or animals often girdle them at infection points. Blister rust gains access to hosts (or any other 5–needle pine) by growing down a needle trace and entering the thin bark of a small stem. Large sugar pines with very thick bark prevent the fungus from establishing stem lesions; but seedlings, saplings, and pole-sizes are infested frequently and thereby killed rapidly compared to mature trees (see Images 3 and 4).

Images 3 &4: Blister Rust canker infested by insects; Canker sporulating.

Red fir forest-type sites like those around Atherton Flat were an interesting mix of old treatments, root disease infection, mortality, and poor site quality. While elevation was suitable for red fir, south facing slopes created drier conditions more suitable for Jeffrey pines. Mature red fir did not appear vigorous and solid – most had dwarf mistletoe in their crowns and *Heterobasidion occidentale* conk was found in an old stump near a landing area. Planted Jeffrey pines also did not appear that well, several looked stunted and needles damaged. Degradation of the site was consistent with patterns of mortality due to expanding root disease centers. Trees along the periphery of an infection are the phases of dying or recently dead, while those closer to the center are snags or fallen logs.

Some campgrounds are part of the Reservoir project, so understandably treatment will differ in these administrative sites. Big Silver campground and trailhead areas were already cleared of recent mortality – pines and firs, but logs were still on the ground and in areas not heavily used (Image 5). Most mortality was in white fir, particularly firs in dense clusters where the entire cluster was eventually killed (3-5 trees in these groups). The percentage of fir remain high on these sites, despite continual mortality of fir most likely due to tight spacing or underground root disease infection.

Image 5. Big Silver campground. Dropped dead white firs within and surrounding campground perimeter.

Overlays of Aerial Detection surveys (ADS)(Forest Health Monitoring 2015-2019) of the past five years show the entire footprint of Reservoir Project as having some level of insect infestation. ADS show upward trends of white and red fir mortality increasing towards the end of the recent drought event, from light to severe (30-50% of designated area affected), particularly some areas west of Table Rock and around Robbs Peak. By 2017, mortality counts of fir were the only ones being observed, while ponderosa pine mortality had slowed considerably. By 2019, fir mortality continued over large areas but has slowed to light levels (4-10% affected). Ground surveys of the southern Sierras found that much of the mortality was on drier sites (ex: ridges, south-facing slopes, rocky soil conditions) or in very dense stands where carrying capacity may have exceeded available resources. The caveat in these consecutive years of mortality is the difficulty in recognizing earlier mortality that has now grayed, lost needles or fallen to the ground. The compounding tree loss due to drought and insect activity has created a long pulse of fuels that may be missed because of the natural fading, but still contributing to long-term heavy fuel loads (Hicke et al. 2012).

Discussion of Proposed Management Alternatives

No Action. Current conditions of most of the project area are categorized as moderate to high risk of Insect and disease according to the National Insect and Disease Risk Map (NIDRM) ratings. Scattered mortality will continue at background levels when annual precipitation is adequate but has shown to more than double once conditions become drier and resources scarce (Fettig et al. 2019). Overcrowded conditions are only allowable if resource needs are met for all trees, but climate predictions estimate that future conditions to be much drier and hotter. These types of conditions can be high energy laden for Sierra Nevada species used to less competition and cooler temperatures during summer and winter. Adaptation is slow, with recent disturbances

occurring at a higher and rapid intensity that even the healthiest of trees cannot withstand or have enough time to recover.

Comparisons of tree mortality in southern Sierra forests (ex: Sierra and Sequoia National Forests) compared to central Sierra forests (ex: Stanislaus and Eldorado National Forest) found that while latitudinal differences played a large role in beetle associated mortality, treated stands were still more resilient than untreated areas Restanio et al 2019). Bark beetles still adhered to typical patterns for site selection initially: high basal area stands, higher proportions of large diameter pines and conspecific trees, and drier sites experiencing chronic physiological stress prior to drought. While drought intensity may not have been as severe on Eldorado NF as southern Sierra forests, mortality was still found in older pine plantations, drier sites, and large diameter trees. In comparison to southern forests, overall mortality was substantially lower but also because of stand differences.

Western pine beetle, the most destructive bark beetle of ponderosa pines in California, responds quickly to favorable conditions for growth and expansion. Fettig et al. 2019 determined that nearly all the mortality that occurred during the last drought event was ponderosa pine (86%) killed by western pine beetle. Beetles in general would prefer not flying too far to find a preferable host, as more exposure time leads to higher rates of predation, energy lost, or environmental forces. Restanio et al. (2019) found that higher proportions of both larger trees and cohorts in ponderosa pine stands were more often infested than areas with higher diversity. Pine plantations especially are at highest risk for infestation – many were 100% killed in Sierra NF regardless of age or past treatment due to the duration and severity of the recent drought (B. Bulaon, *personal observation*). Past thinning treatments did delay beetle attacks, but proximity to nearby infested areas generated strong beetle pressure that stands eventually succumbed. Homogeneous and overstocked conditions make plantations in Reservoir project first to be lost in the next drought event.

Heterobasidion root disease comes in two forms each caused by a different species of fungus. **Fir** annosus is caused by *Heterobasidion occidentale*, **Pine** annosus is caused by *Heterobasidion irregulare*. Pine annosus is so rare in the west side of the Sierras that consequently FHP would not suggest prevention treatments. In contrast, fir annosus is ubiquitous on most Forests that are predominantly white fir type or often confirmed in stands with prior logging or bug kill salvage, thereby serious consideration should be given to the question of whether treatments are even needed. The root disease is very slow moving so hosts are still functioning, although gradually declining in vigor. Thus, hosts become increasingly susceptible to other damage agents or abiotic disturbances resulting in mortality. Although the disease appears to spread radially, it is not spreading clonally. Garbelotto *et al* (1999) has shown that 86% of infected stumps or trees are killed by a different clone of the fungus. Only 14% suggested that the fungus had migrated from a stump or infected tree into adjacent hosts. There is some evidence that suggest where density of white fir is highest the percentage of tree-to-tree infection is also higher. Consequently, FHP still recommends the application of a borate dressing, particularly in areas of high *red* fir density and along the margins of active (white fir) root rot pockets (see Image 6). While the effectiveness of treating white fir might be questioned, if fir annosus is driving stand conversion, it is essential to conserve every possible white fir because resiliency of the mixed conifer-fir vegetation type is dependent upon retaining biodiversity.

Treatments

Forest Health Protection fully support Reservoir FH Project goals and proposed treatments. Primary goal of "improving forest health and composition through the application of appropriate silvicultural prescriptions and fuel management activities" (Reservoir Forest Health Project, Proposed Preliminary Action, February 2020) are in line with recommended actions suggested by numerous studies that conclude density reduction is the most effective method of reducing bark beetle-associated mortality (Fettig et al 2007, Raffa et al. 2008, Restanio et al. 2019) while improving tree growth (Zhang et al. 2013). While some fuel mitigation coincides with bark beetle prevention, treatments may not be enough to prevent undesirable mortality; however, general treatments that do reduce stocking in dense conditions could provide some level of beetle deterrence.

Image 6. Edge of a large root rot pocket where fir annosus is driving species conversion. In this setting, it is essential to conserve every possible white fir tree.

Density reduction, increasing heterogeneity in composition and structure, and adequate stocking levels (of specific site conditions) are all strongly encouraged to mitigate and promote healthy forest conditions, particularly against bark beetles (Fettig et al. 2007, Fettig et al. 2012). Mortality from pests will still occur during drought events, but at low levels and within localized areas which is conducive to natural range of variation for pine and fir forest types in the west (Maloney and Rizzo 2002, Safford and Stevens 2017, Meyer and North 2019). Density reduction is the goal, adjusted based on site conditions or other considerations. However, fuel reduction treatments alone are often not enough to alter conditions to detract beetles (van Mantgem et al. 2011, Fettig et al. 2014). If majority of large-diameter cohorts or overall high basal area remain, these are still at high risk for infestation especially for pine forests (McIver et al. 2013; Restanio et al. 2019). Mechanical treatments alone could not be an adequate substitute for wildfire and should follow thinning treatments whenever possible as both are complementary of the other (McIver et al. 2013). Fuel and bark beetle prevention treatments can be integrated rather than independent or indirect, compromising where compatible treatments may not feasible.

Region 5 Forest Health Protection has developed Forest Health Treatment Priority Mapping (ALL LANDS)[1] which can be used as a suggested overlay of areas that could be included for treatment which fall under highest risk for bark beetle activity. This map was developed using a range of vegetation layers and potential disturbances particularly insects and wildfires. ALL LANDS could be used for prioritizing lands using the 2014 Farm Bill insect

[1] *Forest Health Treatment Priority Mapping (ALL LANDS); briefing paper, July 16, 2018.*

and disease treatment Categorical Exclusion authority under NEPA. Please contact FHP if you have any questions regarding this effort.

Underburning concerns

The district is planning to prescribe burn a total of 16,637 acres within the project area: ~4000 acres following thinning treatment, burn only on ~12,000 acres. While restoring fire return intervals back to historical levels (FRI), local and recent bark beetle activity near proposed project units should be considered as this could unintentionally lead to subsequent bark beetle mortality of surviving trees if conditions are conducive. Fire-injured trees have a higher probability for attack, especially within the first three years post-fire (Davis et al. 2012). If preceding years to planned burning are below-average PDSI, bark beetle activity is often triggered and ramp up by the following year. The combination of fire-injury and high bark beetle activity could result in additional unnecessary mortality. For areas that have prescribed burned (<10 years), these areas likely adjusted to past injury and would be better able to withstand subsequent beetle attack (Hood et al. 2015). Burning post-harvest is typically suggested to wait until following year to give stands respite and time to acclimate. Beetle attraction is typically heightened following stand treatments, that additional disturbance could incite attack and increase aggregation.

Sugar pines are especially vulnerable to low burns that linger at the base, and larger trees are at higher risk than smaller ones (Hood et al. 2010). According fire-marking guidelines for Region 5, sugar pines do not require high percent crown-kill compared to other pines (Smith and Cluck 2011). Observations post-fire by FHP often find more red turpentine beetle attacks at the base of sugar pines than ponderosa pines, even at low burn severities. Mature sugar pines are valuable to regeneration, wildlife, and stand diversity but have been declining due to fire, blister rust, and associated bark beetles (vanMantgem et al. 2004, Stephenson et al. 2019). Losing mature trees could revert succession projections and require manually re-planting to achieve establishment. There is an effective low-cost treatment available for sugar pines that could be applied post-treatment but provides only one-year of protection against bark beetles. Burn and prevention treatments should be monitored carefully especially the first five years post-burn.

Recreation Areas: Hazard trees and individual tree protection.

Campgrounds and other administrative sites may have differing treatment options due to their special category. If treatments are planned to occur nearby, assessments of current site conditions would be efficient to remove potential hazards or provide additional protection if bark beetle activity has been observed. Region 5 Hazard tree guidelines (Angwin et al 2014) are helpful to assess potential trees for defects, signs, symptoms that indicate potential failure of green trees. Individual tree protection (chemical treatments) is only warranted in situations where trees are very high-value or requiring protection to possibly slow down a spreading infestation. Thinning around and within campgrounds is always necessary to ensure public and administrative safety and reduce hazard potential. In any administrative site, Regional Policy[2] dictates that all stumps > 3 inches will be borate-treated as a preventative measure against *Heterobasidion* root disease. Forest Health Protection can provide more guidance regarding alternative root disease treatments.

[2] Forest Service Handbook FSH 34.09.11-2010-1.

Summary

Multiple studies have witnessed natural disturbances that alter, shift, or even amplify under recent climate events. Native bark beetles caused a large proportion of mortality during the CA 2012-2015 drought event (Fettig et al. 2019a) exhibiting their ability to respond quickly to optimal conditions for population growth, easily surpassing thresholds to outbreak if susceptible hosts are widely available (Raffa et al. 2008). Legacy sugar pine counts are dwindling, as well as all other age classes due to blister rust, other damage agents, and competition (Stephenson et al 2019). Urgency for proactive measures is especially important given the virulence of blister rust and eruption potential of bark beetles. Root disease will continue to establish and spread, heightening risk for mortality particularly when drought events occur.

Fettig et al. 2019b (*from* Vose et al., GTR-WO-83, Table 4.2) outlined general strategies for protecting montane forest types which are applicable to mixed conifer forests in California, and Reservoir Project to minimize drought effects and facilitate recovery:

Ecosystem	Drought Management Strategy
Montane	➢ Reduce stand densities and fuel loads through prescribed burning, managed wildfires, and mechanical thinning. ➢ Maintain appropriate stand densities and fuel loads through prescribed burning, managed wildfires, and mechanical thinning. ➢ Use topography and historic fire regimes to drive prescriptions (North 2012, North et al. 2009). ➢ Increase forest heterogeneity. ➢ Salvage dead and dying trees in areas of heavy tree mortality. ➢ Plant drought-tolerant species and genotypes in areas lacking adequate seed sources to rely on natural regeneration. ➢ Prioritize restoration of ecologically sensitive areas (e.g., meadows)

These strategies can be applied to areas that fit site conditions – providing parameters with which they can be effective and supportive to treatment alternatives that move towards resilience or NRV. Current site conditions will regulate the level of necessary treatment, but potential climate change effects that influence native insect and disease responses should also be considered. The Reservoir Project provides a solid template for future projects regarding potential red fir management as well. Activities such as replanting, salvage, and Sporax™ treatments could be used for monitoring of results for future planning. Root disease site monitoring will be implemented by FHP to further disease management and technology. Providing this practical monitoring of treatments in red fir will help gauge for expected outcomes in the future.

If there are further questions regarding biology or regarding this report, please do not hesitate to contact us.

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